Title
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Journal
Psychosomatic medicine, 65(2)

ISSN
0033-3174

Authors
Sullivan, Mark D
LaCroix, Andrea Z
Spertus, John A
et al.

Publication Date
2003-03-01

DOI
10.1097/01.psy.0000058370.50240.aa

Peer reviewed

Depression Predicts Revascularization Procedures for 5 Years After Coronary Angiography

MARK D. SULLIVAN, MD, PHD, ANDREA Z. LACROIX, PHD, JOHN A. SPERTUS, MD, MPH, JULIA HECHT, PHD, MPH, AND JOAN RUSSO, PHD

Objective: Depression has been reported to increase cardiac event rates and functional impairment in patients with coronary disease. This article describes the impact of depression on subsequent healthcare utilization for such patients. **Methods:** One hundred ninety-eight health maintenance organization patients with stable coronary disease were interviewed after elective angiography using a structured psychiatric diagnostic scale. Cardiac events, hospitalizations, procedures, and costs were monitored for the next 5 years through automated data. Subjects were classified at the time of angiography by modified DSM-IV criteria into those with major, minor, and no depression. **Results:** In univariate analyses, the no depression group ($N = 136$) was most likely to receive coronary artery bypass grafting (CABG) (61% vs. 36% in the major depression group vs. 27% in the minor depression group, $p = .001$), and the major depression group ($N = 25$) was most likely to receive percutaneous transluminal coronary angioplasty (PTCA) (44% vs. 14% in the minor depression group vs. 24% in the no depression group). The minor depression group ($N = 37$) was least likely to be hospitalized for cardiac reasons during follow-up (54% vs. 80% in the major depression group vs. 80% in the no depression group, $p = .005$). Five-year rates of myocardial infarction and death did not differ significantly between groups. Proportional hazard models showed that those in the depression groups differed in time from catheterization to CABG ($\chi^2(2) = 11.9$, $p = .003$) and time to PCTA ($\chi^2(2) = 7.74$, $p = .02$) after controlling for relevant covariates. Median regression showed that patients with no depression had higher costs during the first year but tended to have lower costs in years 2 through 5 than patients with minor or major depression. **Conclusions:** Depression status at angiography is associated with the need for revascularization and total healthcare costs for the following year. **Key words:** depression, revascularization, coronary disease, costs, utilization, myocardial infarction.

CABG = coronary artery bypass grafting; CAD = coronary artery disease; DIS = National Institute of Mental Health Diagnostic Interview Schedule for DSM-III-R; GHC = Group Health Cooperative of Puget Sound; HAM-D = Hamilton Depression Rating Scale; HMO = health maintenance organization; PTCA = percutaneous transluminal coronary angioplasty.

INTRODUCTION

Heart catheterization is now the most frequently performed in-hospital operative procedure in patients older than 65 years (1). There is solid evidence that sociodemographic factors such as race and gender affect the medical care that patients with coronary artery disease (CAD) receive (2–7). Nonwhites (2), women (3), and the elderly (4) seem to receive fewer cardiac procedures. Whether psychological factors are significant determinants of the care received by CAD patients is not yet clear. Optimism was recently shown to predict lower hospitalization and procedure rates for 6 months after coronary artery bypass grafting (CABG) (8). Druss et al. (9) recently showed that elderly patients with mental disorders were less likely to receive angiography after myocardial infarction.

How depression specifically shapes the disease course and medical management of a patient with CAD is not clear. There is evidence from multiple sources that psychological factors adversely affect mortality in patients with CAD after controlling for differences in underlying disease severity. Depression, anxiety, hostility, and low social support all increase the risk of cardiac death and myocardial infarction (10). Depression and anxiety also increase symptom severity and functional impairment in patients with CAD (11). Depressive symptoms also predict increased healthcare costs over 4 years in elderly health maintenance organization (HMO) members, across all levels of medical comorbidity (12). Previous studies of costs and utilization in CAD patients have suggested that depression predicts rehospitalization after myocardial infarction (13) or revascularization and may be associated with increased costs of care for CAD patients (14). Antidepressants (15) or psychological interventions (16) may be able to reduce medical costs in these patients. But previous studies have not examined revascularization rates and outpatient utilization or captured all costs.

This article reports 5-year health outcomes in a group of patients assessed by psychiatric interview at

From the University of Washington (M.D.S., J.R.), Seattle, Washington; Center for Health Studies, Group Health Cooperative of Puget Sound (A.Z.L., J.H.), Seattle, Washington; and Mid-America Heart Institute, University of Missouri (J.A.S.), Kansas City, Missouri.

Address reprint requests to: Mark D. Sullivan, MD, PhD, Psychiatry and Behavioral Sciences, University of Washington, Box 356560, Seattle, WA 98195. Email: sullimar@u.washington.edu

Received for publication March 19, 2001; revision received March 1, 2002.

DOI: 10.1097/01.PSY.0000058370.50240.AA

0033-3174/03/6502-0229

the time of coronary angiography. Because previous studies have demonstrated increased symptom severity and healthcare utilization in patients with chronic medical illness who are depressed, we hypothesized that depressed patients with CAD would have higher rates of healthcare utilization, including CABG, percutaneous transluminal coronary angioplasty (PTCA), and hospitalization, as well as increased medical costs during the 5 years after elective coronary angiography.

METHODS

Patient Sample

Patients were recruited from the Group Heath Cooperative of Puget Sound (GHC), a consumer-governed HMO in western Washington serving more than 400,000 patients. GHC is a staff-model HMO that provides comprehensive care on a capitated basis. Members are typically covered through employee-subsidized plans. Members of GHC are similar to Seattle area residents except for a higher educational level and fewer persons at the high and low extremes of income. Coronary disease is managed by GHC primary care physicians in consultation with GHC cardiologists. These cardiologists decide who will go to elective angiography, perform and interpret the angiograms, perform PTCA, and make referrals for CABG.

Because GHC does not operate an independent cardiac catheterization laboratory, GHC cardiologists schedule their angiograms and percutaneous revascularization procedures at other hospitals in the Puget Sound region, including the University of Washington Medical Center. Between December 1991 and February 1993, all GHC members aged 45 to 80 years undergoing elective coronary angiography at the University of Washington for suspected CAD were screened for participation in the study. Inclusion criteria were as follows: 1) at least 50% occlusion of one major coronary vessel by elective angiography, 2) treadmill stress test within the past year (to provide a physiologic, nonanatomic assessment of disease severity), 3) coronary disease was the subject's most disabling disease in the judgment of the patient's primary care physician, and 4) the subject was ambulatory at the time angiography. Patients needing emergent angiography for unstable angina or undergoing angiography as inpatients after an acute myocardial infarction were excluded to form a cohort of patients with stable CAD. Of 363 patients undergoing angiography at the University of Washington Medical Center during the 15 months of patient enrollment, 240 (66%) were eligible, and 206 (86% of eligibles) provided consent and completed an extensive baseline psychosocial interview. The most common reason subjects were ineligible was a lack of a treadmill test in the past year ($N = 82$). We report here on the 198 subjects (82% of those eligible) who remained enrolled in the GHC system throughout the next 5 years to ensure complete capture of subsequent resource utilization.

Potential subjects were contacted by phone before their scheduled coronary angiography by the study coordinator, who described the study and obtained preliminary consent to meet with them in the hospital. After complete description of the study to subjects, written informed consent was obtained at the time of the interview. Consenting subjects were interviewed by a research nurse in their hospital room after angiography while they waited for hemostasis of their groin wound. Interview after angiography has been shown to yield reliable and valid psychosocial data in previous studies (17). Research procedures were approved by the Human Subjects Committees of the University of Washington and the Group Health Cooperative of Puget Sound.

Measures

Independent variables. Baseline interviews included assessment of demographic information and depression diagnoses using the National Institute of Mental Health Diagnostic Interview Schedule for DSM-III-R (18) (DIS) and the Hamilton Depression Rating Scale (19) (HAM-D). Periodically throughout the study, Dr. Sullivan, a board-certified psychiatrist, rated the patient with the DIS and HAM-D simultaneously with the nurse to verify reliability.

Scoring procedures for the DIS were modified for the setting and patient population as follows. Rather than use the "etiologic" strategy for depression diagnosis (in which patients are questioned about what their doctor thinks is causing a possible depressive symptom), we used an "inclusive" diagnostic strategy in which all somatic symptoms of depression counted toward a possible diagnosis regardless of their possible association with coronary disease. This diagnostic approach has been advocated in the medically ill to prevent underdiagnosis (20). It may be especially appropriate in heart disease, in which symptoms such as fatigue may be more closely associated with emotional distress than cardiovascular fitness (21). Because of underreporting of dysphoria in older males (who were predominant in our sample) (22), we allowed a positive response to either the DIS dysphoria item or the HAM-D dysphoria item (which allows for interviewer observation as well as subject self-report) to qualify as a symptom for depression diagnosis. Subjects were then divided into three groups according to DSM-IV criteria for major depressive episode and minor depressive disorder (DSM-IV appendix): major depression (five or more DSM-IV symptoms, including dysphoria or anhedonia), minor depression (two to four DSM-IV symptoms, including dysphoria or anhedonia), or no depression (zero to one DSM-IV symptom).

Baseline. Standard clinical indices of cardiac disease severity were obtained from patients' outpatient testing records and hospital charts. Various measures derived from coronary angiography and treadmill stress testing were considered as objective measures of disease severity. We used the number of main vessels (left main, left anterior descending, circumflex, right coronary) that are more than 70% occluded as our overall CAD severity measure because at this level occlusion becomes hemodynamically significant and because this disease severity variable showed the strongest relation to physical function in previous analyses. Although left main occlusion is associated with higher mortality in other studies, it did not behave differently from occlusion of the other main coronary arteries in our sample. It was therefore included in the overall CAD severity measure. Also considered were the maximum percentage of occlusion across seven coronary arteries (left main, left anterior descending, circumflex, right coronary, diagonal(s), obtuse marginal(s), and posterior descending), because it more fully captures the ischemic burden to the myocardium; amount of ST depression on treadmill stress test (as a more direct measure of ischemia); and left ventricular ejection fraction (as a measure of cardiac pump function). These variables were not included in the final models because they did not add significant predictive power to the 70% occlusion variable.

A pharmacy-derived chronic disease score was used to control for medical comorbidity. It was calculated on the basis of pharmacy use during the first year of follow-up. This chronic disease score has been found to correlate highly with primary care physicians' ratings of the severity of patients' illnesses as well as with hospitalization and mortality in the subsequent year (23). It has been used extensively in outcomes research to control for the effect of comorbid chronic diseases (24).

Study outcomes. Outcomes included procedures, events, cardiac hospitalizations, and total annual medical costs across 5 years of follow-up. These outcomes were obtained from computerized databases that contain detailed information on all medical encounters at GHC. Procedures included CABG and PTCA. Events included myocardial infarction and death. Myocardial infarction rates were obtained by assessing automated data for new inpatient or outpatient ICD-9 codes (410.xx) for acute myocardial infarction appearing during the follow-up period. Cardiac hospitalizations include any hospitalizations occurring during the follow-up period with a primary diagnosis related to coronary heart disease (ICD-9 codes 410.xx–414.xx and 420.xx–429.xx). Total costs included costs of GHC-performed procedures and diagnostic tests, all GHC hospitalizations, all visits to GHC outpatient clinics, and all prescriptions filled at GHC pharmacies. More than 95% of all prescriptions filled by GHC members are filled at GHC pharmacies (25). The automated cost accounting system at GHC tracks all costs, not charges, of each visit, including overhead costs. Therefore, the total cost figures reflect the total costs from the perspective of the HMO. Because we examined costs across a 5-year period, costs were standardized to 1998 dollars using an inflation rate of 3%.

Statistical Analyses

Our analyses focused on differences between the three depression groups identified at the time of angiography. We describe baseline characteristics of these three groups using proportions, means, and standard deviations. Baseline differences between groups were tested using analysis of variance for normally distributed variables and median test for nonnormally distributed variables. Five-year rates are based on the proportion of patients who experienced at least one procedure, event, or cardiac hospitalization during the 5 years after diagnostic angiography. Chi-square tests were used to test for between-group differences in unadjusted rates. Cox proportional hazard models were used to compare the time to first CABG and PTCA after catheterization for patients with major vs. minor vs. no depression at baseline while adjusting for demographic characteristics (age, sex, high school education), medical comorbidity (chronic disease score), previous revascularization, and baseline disease severity (number of main coronary arteries occluded >70% and amount of ST depression on the treadmill stress test). Covariates were entered in a forward stepwise procedure according to the likelihood ratio with only significant covariates (p = .05) retained in the final model.

We compared healthcare costs for the three depression groups using median regression because the cost data were highly skewed and not amenable to parametric analysis. These models controlled for the same covariates as the logistic regression models. Costs were assigned to the year they occurred and were analyzed with a repeated-measures approach, which allows for differences in yearly costs to be detected. To calculate confidence intervals, 1000 bootstrap models, with replacement, were performed.

RESULTS

We had complete 5-year follow-up data for 87% (172 of 198) of our initial sample. Ten patients died, and 16 withdrew from GHC during follow-up. Observation of these individuals was censored at the point of disenrollment. All 26 patients experienced at least one hospitalization, 17 had at least one CABG, and 7 had at least one PTCA.

Table 1 displays the baseline characteristics of the entire sample and across the three depression groups. Depression groups differed significantly by age, sex, education, medical comorbidity, HAM-D scores, and number of DSM-IV depression symptoms. Subjects in the depression groups were younger, more likely female, more educated, and had higher levels of medical comorbidity. Depression groups did not differ signifi-

TABLE 1. Sample Characteristics at Baseline[a]

Variable	Total Sample (N = 198)	Major Depression (N = 25)	Minor Depression (N = 37)	No Depression (N = 136)	p
Age	62.0 ± 9.3	56.8 ± 9.8	60.5 ± 9.3	63.2 ± 8.9	.0001[b]
Male gender	82.8%	68.0%	78.4%	85.9%	.0003[b]
Education > high school	62.1%	72.0%	67.6%	60.0%	.05[b]
Chronic disease score	6.0 ± 2.5	6.5 ± 3.0	6.6 ± 2.8	5.9 ± 2.3	.001[b]
Number of main coronary arteries with >70% stenosis	1.5 ± 0.8	1.4 ± 0.9	1.5 ± 0.8	1.6 ± 0.9	.95[b]
Maximum stenosis Left main	12.1 ± 23.0	6.8 ± 17.7	10.3 ± 19.6	13.2 ± 24.5	.51[c]
Other coronary arteries	90.0 ± 16.0	86.5 ± 22.5	91.4 ± 13.6	90.5 ± 14.9	.15[c]
Previous CABG	19%	24%	26%	16%	.34[d]
Previous PTCA	10%	14%	6%	10%	.60[d]
Hamilton anxiety score	12.3 ± 6.8	18.4 ± 8.8	17.3 ± 6.6	10.3 ± 5.1	.0001[b]
Hamilton depression score	9.1 ± 6.1	15.9 ± 7.5	13.8 ± 5.7	6.8 ± 4.2	.0001[b]
Number of DSM-IV depression symptoms	2.4 ± 2.2	6.4 ± 2.0	3.0 ± 0.7	1.5 ± 1.5	.0001[b]
Lifetime dysthymia	4%	21%	3%	2%	.0001[d]
Any antidepressant at any point during follow-up	25%	44%	31%	21%	.02[d]

[a] Values are mean ± SD unless otherwise noted.
[b] By analysis of variance.
[c] By median test.
[d] By chi-square analysis.

cantly on measures of baseline coronary disease severity or on rates of previous revascularization.

Table 2 displays 5-year rates for procedures, events, and cardiac hospitalizations. There were significant differences in rates of both revascularization procedures across groups. Patients with no depression had the highest rates of CABG, whereas patients with major depression had the highest rates of PTCA. Patients with minor depression had the lowest rates of CABG and PTCA (Fig. 1). Post hoc chi-square analyses among depression subgroups showed that subjects in the major depression ($\chi^2 = 3.99$, $p = .05$) and minor depression ($\chi^2 = 16.11$, $p = .001$) groups were significantly less likely to receive CABG than subjects in the no depression group. The major and minor depression groups did not differ from each other in rates of CABG ($\chi^2 = 1.72$, $p = .19$). The major and minor depression groups did differ in rates of PTCA ($\chi^2 = 7.24$, $p = .007$), but neither group differed from the no depression group in PTCA rates. No significant differences in the rates of death (major depression, 4%; minor depression, 0%; no depression, 4%; $p = .1$) or myocardial infarction (major depression, 0%; minor depression, 8%; no depression, 5%; $p = .4$) were found between the depression groups. Patients with minor depression had the lowest rates of cardiac-related hospitalizations.

Cox proportional hazard models for time to CABG or PTCA that controlled for statistically significant baseline covariates—age, gender, education, medical comorbidity, CAD severity on angiography (number of main coronary arteries occluded >70%), CAD severity at treadmill stress testing (maximum millimeters of ST depression), and previous CABG or PTCA—showed similar results. Patients in the depression groups differed from patients in the no depression group in time to CABG ($\chi^2(2) = 11.9$, $p = .003$) and time to PTCA ($\chi^2(2) = 7.74$, $p = .02$). These effects were largely due to increased time to CABG in the minor depression group compared with the no depression group (Wald's $t = 8.2$, $p = .004$) and decreased time to PTCA for the major depression group compared with the no depression group (Wald's $t = 5.3$, $p = .02$). CAD severity on angiography (number of main coronary arteries occluded >70%) was retained as a significant covariate in the final models, but CAD severity at treadmill stress testing (maximum ST depression, in millimeters) was not. The depression group results did not change with inclusion of all covariates.

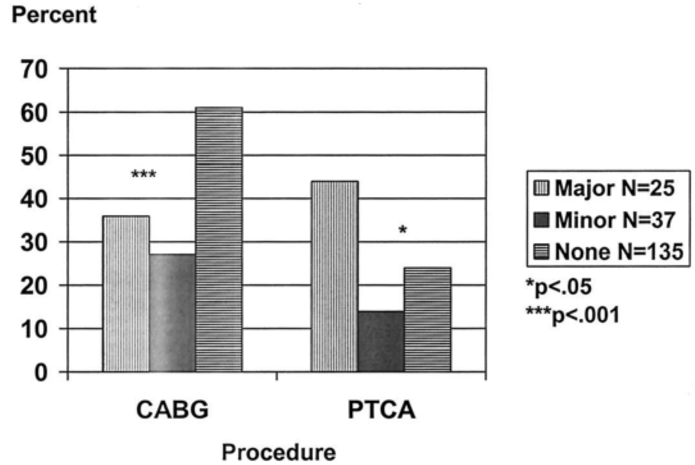

Fig. 1. Five-year procedure rates by baseline depression diagnosis. Major ▥ N = 25; minor █ N = 37; none ▤, N = 135. * $p < .05$; *** $p < .001$.

Table 3 shows observed annual costs for the 5 follow-up years. Across groups, costs were highest in the first year after diagnosis, stabilizing to a much lower level in subsequent years. Because of these patterns, the models we used compare costs in the first year of follow-up to averaged annual costs across follow-up years 2 through 5. Patients with no depression at baseline had higher costs during the first year after angiography than patients with minor depression (median differential = $22,911, 95% confidence interval = $7561–$26,667) but not patients with major depression (median differential = $7195, 95% confidence interval = −$5163–$17937). In subsequent years, costs of nondepressed patients tended to be lower, and costs for patients with minor or major depression tended to

TABLE 2. Five-Year Procedure, Event, and Hospitalization Rates

5-Year Outcomes (% Yes)	Total Sample (N = 198)	Major Depression (N = 25)	Minor Depression (N = 37)	No Depression (N = 136)	χ^2 (p)
Procedures					
CABG	51%	36%	27%	61%	15.8 (.001)
PTCA	25%	44%	14%	24%	7.5 (.02)
Events					
MI	3%	4%	0%	4%	0.1 (NS)
Death	5%	0%	8%	5%	0.4 (NS)
Utilization					
Cardiac hospitalization	75%	80%	54%	80%	10.7 (.005)

TABLE 3. Observed Total Healthcare Costs for the Three Groups in 1998 Dollars

Time	Major Depression			Minor Depression			No Depression		
	N	Median ($)	Mean (SD) ($)	*N*	Median ($)	Mean (SD) ($)	*N*	Median ($)	Mean (SD) ($)
Year 1	25	21,022	24,478 (18.702)	35	8864	19,359 (19,560)	128	31,200	29,191 (20,573)
Year 2	24	4528	7868 (12,535)	35	2978	6320 (9033)	122	2130	6648 (11,832)
Year 3	23	2527	7994 (17,209)	33	3711	4969 (4574)	118	2207	5697 (9695)
Year 4	21	2207	8332 (18,149)	31	3166	4872 (6197)	116	2440	6148 (11,179)
Year 5	21	4386	8067 (14,526)	29	3464	4552 (4321)	112	2216	5520 (9319)
Total		34,670	56,739		22,183	40,072		40,193	53,204

be greater (minor vs. no depression: median cost difference = +$807, 95% confidence interval = −$1522–$526); major vs. no depression: median cost difference = +$851, 95% confidence interval = −$1104–$2083).

DISCUSSION

In this study of patients with documented CAD, depression diagnosis at the time of angiography significantly predicted CABG and PTCA procedure rates over the next 5 years. Patients with major or minor depression at the time of angiography had significantly lower CABG rates during follow-up than those with no depression. Patients with major depression at angiography had the highest rates of PTCA. Patients with minor depression had the lowest rates of cardiac-related hospitalizations. These procedure and hospitalization differences were reflected in significant differences in total costs of care for these patients. Patients with no depression had the highest costs in the first year after angiography and lower costs thereafter. No significant differences in the rates of death or myocardial infarction were found between the depression groups.

The higher procedure rates and first-year costs in the no depression group were contrary to our hypotheses. These findings must be interpreted in light of how the study cohort was formed. All patients in this cohort were required to have at least 50% occlusion in at least one of the left main, left anterior descending, circumflex, or right coronary arteries for study entry. Angiography patients who did not have at least this degree of coronary disease were excluded. Patients with major depression had the most PTCA procedures during follow-up. This is perhaps because patients were required to have at least single-vessel disease to be included in the study cohort. Patients with major depression were more likely to have just enough coronary disease to get into the study cohort (only 40% of the major depression group had multivessel coronary disease, compared with nearly 50% of the no depression group; p = NS). In addition, the no depression group had the lowest rate of previous CABG (16% vs. 24% in the major depression group vs. 26% in the minor depression group; $p = .34$), which may have increased the likelihood of CABG in that group during the follow-up period.

Depressed patients with coronary disease have been shown to have more severe angina (26) and fatigue (27) than nondepressed patients. They also tend to be more concerned that these symptoms indicate serious disease (28). It is well known from other studies that patients with negative results on coronary angiography have higher rates of depression and panic disorder and are more disabled than patients with positive angiography results (29). We believe these effects of depression on symptom awareness and reporting led to earlier referral to angiography and lower rates of multivessel disease on angiography for the depressed patients in our study. In our study, those with major depression had fewer main coronary vessels occluded >70% per coronary symptom (0.55 vs. 0.85 in the other groups, $p = .05$).

Recently published reports have raised the possibility of physician bias in referral for angiography based on psychiatric disorders and for revascularization based on race, gender, and social class. Thus we should consider whether physician bias may account for our findings. Though primary care physicians were notified of depression status after our interview (per Institutional Review Board protocol), the cardiologists who made the decisions concerning revascularization were blinded to depression status. Thus referral bias is unlikely. Patients in the depressed groups were younger and more likely to be female, factors associated with less severe coronary disease and less surgical intervention. However, the differences between the depression groups remain significant after age, gender, race, and social class are controlled. Therefore, it does not seem that psychological or social bias accounts for our findings. Rather, we believe that our results derive from the two-step process leading to revascularization: 1) Patients are referred to angiography on the basis of symptomatic and functional impairment suggesting coronary disease (plus the positive treadmill test, which all our subjects had). This level of impairment is strongly shaped by depression, as shown by us and others. 2) Patients are referred from angiography to revascularization largely on the basis of occlusions revealed at angiography. This process is not directly affected by depression status in our view. Replication of our findings will be needed to confirm this interpretation.

Using national hospital claims data, Druss et al. (30) found that patients with affective disorders had a relative risk of 0.5 for receiving PTCA and 0.6 for receiving CABG. However, when the analyses were restricted to those undergoing angiography, the differences became nonsignificant. The Druss et al. study suggests that mental disorders primarily affected rates of referral *for* angiography. Our experience reveals differences in revascularization rates *after* angiography. This may be attributable to the better classification of our patients' mental health. We used structured psychiatric interviews rather than hospital admission diagnoses to identify cases of depression. These interviews are both more sensitive and specific case-finding tools. Misclassification of patients' depression status in the Druss et al. study may have biased their findings toward the null hypothesis.

Because of its high rate of CABG, the no depression group had the highest healthcare costs in the first year after angiography. The depression groups had lower rates of CABG and lower healthcare costs in this first year after angiography. During years 2 through 5, the depression groups trended toward greater costs. This may reflect the greater problems with symptoms and disability in the depression groups, as demonstrated in our previous report (11).

The lowest rates of CABG, PTCA, and cardiac hospitalization during the 5-year follow-up were found in the minor depression group. After angiography, they received the least aggressive medical care. This is difficult to explain because previous studies by our group (31) and others (32) have shown rates of disability and healthcare utilization in patients with minor depression to be intermediate to those with major depression or no depression. Post hoc review of the angiography data revealed the minor depression group consistently had the lowest rates of high-grade (>90%) lesions of the three groups, although the difference was nonsignificant. The minor depression group also received less revascularization in patients with borderline (ie, 50% to 70%) occlusions on angiography. Thus, angiographic differences (ie, number of arteries occluded >90%) and nonangiographic differences (ie, different management of borderline occlusions in the different groups) may both be accounting for the low rates of revascularization in the minor depression group. The low rates of utilization in the minor depression group may be due to their less chronic course of depression compared with the major depression group. For example, by 1 year after angiography, the median HAM-D score in the minor depression group had dropped to 7, whereas in the no depression group it was 3 and in the major depression group it remained at 14. This chronicity is expected given the greater rates of dysthymia in the major depression group. It is also important to note that the sample size and event rates in the minor depression group were low enough that the statistical methods used may not be reliable. Replication of these findings is needed.

Although previous studies on CAD samples have shown effects of depression on mortality using sample sizes and follow-up periods similar to ours (33), we did not show this. We had very low rates of death and new myocardial infarction in our sample during 5 years of follow-up. Our angiography cohort comprised lower risk patients than prior studies, which often followed patients after an acute myocardial infarction. It is possible that we would see significant effects of depression diagnosis on death and event rates with greater power by examining a larger sample or having a longer follow-up period. Twenty-five percent of our sample (including 44% of the major depression group and 33% of the minor depression group) received some antidepressant during the 5-year follow-up period. Previous studies of GHC patients receiving antidepressants have shown that less than half receive adequate treatment according to the guidelines of the Agency for Health Care Policy and Research (34). In our study depression treatment introduced a conservative bias by tending to erase utilization differences between groups.

Some limitations of our study should be noted. First, depression diagnostic groups were formed on the basis of a single structured interview conducted at the time of angiography. Depression status likely varied during the 5 years of follow-up. However, our previous analyses of data from this cohort have indicated that levels of depressive symptoms generally improve during the first year after angiography (35) but remain quite stable thereafter (11). Second, CAD severity was assessed only at baseline angiography. It is possible that subgroups of patients may have different rates of CAD progression and therefore different revascularization rates. Third, our sample was largely male, white, and middle class. Our findings may not be generalizable to other groups of CAD patients. Fourth, these results all derive from a single staff-model HMO. Rates of procedures may differ in systems of care with different incentives. Fifth, 54 otherwise eligible angiography patients were excluded from participation because they did not have a treadmill stress test in the past year. They were excluded because we had planned to use data on ischemia at stress testing as part of our CAD severity measure. But this data added no predictive power to our angiography data and was not included in our analyses. Thus the requirement of a treadmill test may limit the generalizability of our findings to only those coronary patients with both angiography and treadmill stress testing.

It is well established that patients with major or minor depression have increased rates of physical symptoms, disability, and healthcare utilization (36). Many patients with depression present exclusively with physical symptoms even though emotional distress can be elicited on direct questioning (37). Men are especially likely to describe their distress in physical terms. This reporting of distress in physical terms is especially difficult for physicians to decode when it occurs in the context of another chronic and life-threatening disease such as CAD. Our previous studies have shown that depression diagnosis affects the trajectory of symptoms and functional status for this cohort of CAD patients (38). The present study shows that depression diagnosis also affects the patterns of care received throughout 5 years of the disease course of a CAD patient. Factors beyond organ impairment seem to play an important role in the medical and surgical care of patients with coronary disease. Our study suggests that these include depression-driven symptom amplification. Greater attention to depression in CAD patients may allow physicians to provide more appropriate and cost-effective care for them.

Supported by National Institutes of Health Grant K01 MH01351 (to Dr. Sullivan). We acknowledge Wayne Katon, MD, for review of an earlier draft of the manuscript, Darlene White for study coordination, Heidi Jantz for conducting study interviews, and Alison Major for secretarial assistance.

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